

FUTURE MISSIONS TO MARS

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The United States has undertaken a **decadal** program of Mars exploration referred to as the Mars Surveyor Program. The overarching objective of the program is to explore and characterize the **martian** environment in terms of life, climate, and resources. Because of the recent results associated with the study of the **martian** meteorite **ALH84001** and the proposition that it may contain evidence of past life on Mars, the program's focus has shifted toward the question of life.

The general philosophy behind the implementation of the Mars Surveyor program is to move from the era of **orbital reconnaissance** to detailed surface exploration and sample return. The orbital missions will provide the general contextual data for a basic understanding of Mars. Surface missions will provide the detailed in situ information about the chemistry, mineralogy, and environment of the planet and provide ground truth for the orbital measurements. In terms of the question of life, the philosophy is to focus on the ancient environment where water and heat were available and the environment for the development of life might have occurred. The presence of fossil evidence seems more likely and easier to find than extant life. The search will not focus on finding a macroscopic physical fossil, but will seek to determine whether there is chemical and morphologic data to suggest **prebiotic**, **protobiotic** or biotic activity on Mars.

The current mission set includes the Pathfinder, Mars Geosciences Orbiter, 1998 Orbiter, Mars **Volatiles** and Climates Surveyor, 2001 **Geochemical** Orbiter, 2001 Lander and Rover, 2003 Lander and Rover, and a sample return mission in 2005. Pathfinder and the Mars Geosciences Orbiter were launched in *December 1996* and are currently enroute to Mars.

Pathfinder will land in the flood plain of the catastrophic outflow channel Ares **Vallis** and with its small rover explore the landing site. The geologic context of Ares **Vallis** suggests that a diverse suite of materials carried down stream have been deposited at the site. This should provide a much better understanding of the types of rocks that occur on Mars by obtaining spectral data for mineralogy and elemental analysis of the surface materials.

Mars **Geosciences** Orbiter will largely recover the scientific objectives that were carried aboard the ill fated Mars Observer spacecraft. Mission objectives include altimetry (laser altimeter), mineralogy (thermal emission spectrometer), surface morphology and synoptic observations (imaging system), gravity field (spacecraft tracking), and magnetic field. The spacecraft will be placed in a polar orbit and it will collect data for one martian year. This mission will essentially complete the global reconnaissance phase of Mars exploration.

The 1998 Orbiter has two main science objectives: the **temporal** and spatial **character** of the atmosphere and the morphology of the surface. The thermal and water vapor structure of the atmosphere over space and time will be assessed (pressure modulator infrared radiometer) and the surface morphology will be mapped (imaging) from the polar orbiting spacecraft.

The Mars **Volatiles** and Climate Survey will place a lander on the martian surface at the high southern latitudes (7 10S / 210°W). Mission objectives include: characterize the surface environment, weather and geology; examine the nature and isotopic composition of **volatiles** (CO₂, H₂O) on and just below the surface, and determine the mineralogy of

surface materials. The payload includes descent and surface imaging, a thermal and evolved gas analyzer, robotic arm for sampling, and meteorology package.

The 2001 **Geochemical** Orbiter has as its primary objectives a characterization of the geochemistry and mineralogy of the planet. It will carry a gamma ray and neutron spectrometer to map the elemental composition of the surface and the near-surface H (i.e., water) distribution, a **spectrometer** (emission or reflectance) to determine surface mineralogy, an imaging system to assess surface morphology, and a radiation monitor.

A lander and rover will also be launched in the 2001 opportunity. The surface missions have two overarching objectives: providing environmental information necessary to plan for the human exploration of Mars, and exploring sites which have a high potential for preserving evidence of **prebiotic** or biotic processes. This mission will land in the ancient highlands of Mars. The lander is designed to provide a short lived platform to **characterize** the chemistry and physical properties of the surface and atmospheric dust, assess the surface radiation **environment**, and demonstrate aspects of an in situ propellant production facility. The rover for this mission has as its primary objective the characterization of the geologic environment and the collection and caching of samples. The rover will have the ability to traverse tens of kilometers and is expected to surface for at least one Earth year. Instrumentation will include imaging for navigation and geology, **spectrometry** for **remote** mineral detection, additional instrumentation for elemental and **mineralogic** information, as well as a system to collect samples from hard rocks and soft materials.

The 2003 lander and rover will be similar to the design for 2001. The experiments for the lander have yet to be determined. Although the instrumentation for the rover in 2003 may differ from those included in 2001, the basic objectives of the surface mission will remain the same, to provide environmental data and samples relevant to the question of life.

Both the **2001** and 2003 missions will collect and cache samples. Then in the 2005 opportunity, a mission will be launched to Mars to collect one of the two caches. As the 2001 and 2003 sites will be widely separated, samples from only one will be returned. The collection and return functions have been separated into different missions such that at least two different geologic sites can be visited, to provide technical and scientific redundancy and because the sample return vehicle can survive on the surface for only a few weeks (insufficient time to conduct a sample collection mission). The decision about which cache to return **will** be based on **all** of the data in hand at the time of the 2005 mission.

The longer term aspects of the program remain undecided. It is understood that a single sample return mission from Mars will not resolve the question of life on Mars and that many sample return missions will be required. In addition as more is learned about Mars, additional scientific questions will develop which in turn will require additional observations from orbit and from the surface.